APPENDICES

IN THE

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, A. D. 1940

STATE OF WISCONSIN, STATE OF MINNESOTA, STATE OF OHIO and STATE OF PENNSYLVANIA, *Complainants*, *vs.* STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, *Defendants.*	No. 2 Original
STATE OF MICHIGAN, *Complainant*, *vs.* STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, *Defendants.*	No. 3 Original
STATE OF NEW YORK, *Complainant*, *vs.* STATE OF ILLINOIS and THE SANITARY DISTRICT OF CHICAGO, *Defendants.*	No. 4 Original

ARGUMENT IN SUPPORT OF EXCEPTIONS FILED BY THE STATES OF WISCONSIN, MINNESOTA, OHIO, PENNSYLVANIA, MICHIGAN AND NEW YORK TO THE REPORT OF SPECIAL MASTER LEMANN, DATED MARCH 31, 1941.

APPENDIX I.

PREFACE.

The exceptions filed by the opposing Great Lakes States to the report of the Special Master, as we have noted hereinbefore arise only in the event that it should be held by the Court that an actual menace to the health of the inhabitants of the complaining communities exists. No health menace in fact exists. It will therefore be unnecessary for the court to consider arguments and discussion which follow herein. However for the convenience of the Court and to preserve for the record the position of the opposing Great Lakes States, in order to protect their right to findings on the matters discussed herein, if, at any time an issue is raised in which those matters become important, we have included an argument in support of such exceptions as an appendix to this brief.

1. ARGUMENT ON THE EXCEPTION RELATING TO REMEDIAL OR AMELIORATING MEASURES.

III. "WITH RESPECT TO THE FEASIBILITY OF REMEDIAL OR AMELIORATING MEASURES AVAILABLE TO THE STATE OF ILLINOIS WITHOUT AN INCREASE IN THE DIVERSION OF WATER FROM LAKE MICHIGAN."

The third issue of fact (discussed in this Brief at pages 77 to 104) with respect to the feasibility of ameliorating or remedial measures available to the State of Illinois without any increase in diversion of water from Lake Michigan, arises only in the event that the Court should hold that an actual menace to the health of the complaining communities exists. The finding of the Special Master that no actual menace to health exists disposes of the

issues raised on the Reference of April 3, 1940. This finding of the Master is amply sustained by the record and will, we believe, be affirmed by the Court. Hence it will be unnecessary for the Court to consider the discussion herein of the available feasible remedial measures. However, as we indicated in our Exceptions which were filed with this Court on April 15, 1941, we wish to place upon the Record our position with respect to feasible ameliorating measures available to the State of Illinois without an increase in diversion of water from Lake Michigan. This is to protect the respondent Great Lakes States in the event that this question should again arise in the future to the end that appropriate findings thereon may be made.

(a) The accumulation of sewage wastes and sludge in the Sanitary District Canal and in the Brandon Road Pool has not created at any time any nuisance condition affecting public health, nor has the actual condition of the Illinois Waterway at any time constituted an actual menace to the health of the inhabitants of the complaining communities and, while no remedial or ameliorating measures are in any wise necessary to protect the interests of public health, neverthless there are a number of remedial or ameliorating measures available to the State of Illinois without an increase in water from Lake Michigan which would improve the present condition of the Illinois Waterway.

It is the position of the respondent Great Lakes States that it has been proven and established by evidence that the actual condition of the Illinois Waterway, by reason of the introduction of untreated sewage, has not at any time and does not now constitute a menace to the health of the inhabitants of the complaining communities and that the accumulation of sewage wastes and sludge in the Sanitary District Canal and in Brandon Road Pool has

not created any nuisance condition, affecting public health, and that the adoption of remedial or ameliorating measures available to the State of Illinois without an increase in the diversion of water from Lake Michigan is in no wise necessary to protect the interests of public health or navigation, nevertheless there are a number of remedial or ameliorating measures available to the State of Illinois without an increase in diversion of water from Lake Michigan which could be undertaken, either singly or by a combination of one or more thereof.

(b) The remedial or ameliorating measures which are feasible and practicable and available to the State of Illinois without an increase in the diversion of water from Lake Michigan are many.

1. *The lagooning of all sludge from the west-southwest area not converted into fertilizer nor deposited on spoil banks so as to keep out of the main channel all sludge from partially or completely treated sewage. Lagooning is now being practiced by the Sanitary District of Chicago.*

The lagooning of all of the sludge from the West-Southwest Side area not converted into fertilizer nor deposited on spoil banks to the end that such sludge may be kept out of the main channel is now being practiced by the Sanitary District of Chicago. As the Special Master points out, lagooning as a partial ameliorating measure was only adopted by the Sanitary District of Chicago since the hearings before the Master began (Report of Special Master Lemann, p. 65). The suggestion of the opposing Great Lakes States that lagooning be practiced by the Sanitary District was at first strenuously opposed but was later adopted so that after October, 1940, no more sludge is discharged into the Illinois Waterway except what appears in the suspended solids contained in the incompletely

treated effluents of the West and Southwest plants. The adoption of lagoons by the Sanitary District of Chicago is one of the most important steps that could be taken to obtain and maintain satisfactory sanitary conditions in the Illinois Waterway (Warrick, R. 2108, JA-I, 475; Ellms, R. 2089-90, JA-I, 454; Enslow, R. 1985, JA-I, 393; Howson, R. 1940-1942, JA-I, 338-339; Pearse, R. 210, JA-I, 103; Mohlman, R. 1875, JA-I, 216; Calvert, R. 2622-2623, JA-I, 268).

2. *The use of chlorine in the water of the Main Channel of the Chicago Drainage Canal and in the water of the Brandon Road Pool for odor control and reduction of B. O. D. This could be undertaken during the summer of 1941.*

(a) In general.

One of the remedial or ameliorating measures available to the State of Illinois without any additional diversion of water from Lake Michigan is the use of chlorine for odor control and for the reduction of B. O. D. Examination of the evidence in the present record discloses that chlorine may be effectively used to prevent odors and to reduce the B. O. D. in the waters of the Main Channel of the Chicago Drainage Canal and in the Brandon Road Pool so as to improve the unsatisfactory conditions which obtained in the year 1939.

The controversy between petitioner's witnesses and the witnesses of the respondent Great Lakes States relates to the amount of chlorine to be used, the places where the chlorine is to be applied and the cost to the Sanitary District of Chicago in the use of chlorine as an ameliorating or remedial measure herein.

The Special Master observed:

> " . . . as I have followed the testimony, I believe everybody would agree that chlorine is an effective

agent. My impression is that hasn't been denied even by the experts for Illinois, and the whole contention is going to be about the amount of cost that would be required for effective chlorination in an enterprise of this character. Of course, we know Chicago is the second largest city in the United States and the third largest in the world, and everything in Chicago is on a large scale. . . .'' (R. 2110).

Mr. Enslow, one of the witnesses called by the respondent Great Lake States to testify concerning the use of chlorine as a remedial or ameliorating measure available to the State of Illinois without the use of additional water from Lake Michigan, testified that the amount of chlorine required for odor control and the reduction of B. O. D. so as to provide pasteurization, not sterilization, would be a minimum of 27 tons per day (R. 2070-2072, JA-I, 408-409); with a maximum of 75 tons per day (R. 2072, JA-I, 409). He estimated the cost of the chlorine treatment plants required at the Southwest Side Plant and at the Brandon Road Pool at no more than $85,000 for each building, which was the cost of the 27-ton chlorine plant at Detroit, Michigan (R. 2025-2027, JA-I, 407-408).

Mr. Enslow in the light of his vast experience with the use of chlorine for odor control and for the reduction of B. O. D. was satisfied that the proper use of chlorine would greatly ameliorate the conditions complained of on the Illinois Waterway (R. 1987-1990, JA-I, 393-394). While he stated that in his opinion there was no exact parallel case in existence for the use of chlorine because of such a deep river underlaid by sludge (R. 2924, JA-I, 415), he was nevertheless confident that because of his knowledge of worse conditions elsewhere, of waterways which were improved by the use of chlorine, that chlorine would be an effective agent in ameliorating or remedying the conditions in the Main Channel of the Chicago Drain-

age Canal and in Brandon Road Pool (R. 1987-1990, JA-I, 393-394).

Mr. Enslow further testified that the use of chlorine as an ameliorating measure for odor control and reduction of B. O. D. would be more effective than the additional diversion of 350 c. f. s. from Lake Michigan (R. 2003).

Dr. A. M. Buswell, chief of the Illinois State Waterway Survey, another witness called by Respondent Great Lakes States testified that chlorine is widely used for the prevention of odors and is effective in the reduction of B. O. D. (R. 1896, JA-I, 435). He stated that chlorine properly applied in the Canal would prevent the odors complained of (R. 1897-1898, JA-I, 435-436), and that chlorine in the amount of one to three p. p. m. would be enough (R. 1899, JA-I, 436). He was of the opinion that the amounts of chlorine he testified to would be as effective in ameliorating the condition complained of as the oxygen from an additional diversion of 3500 c. f. s. (R. 2256, JA-I, 442). He estimated the cost of chlorine over a 100 day period in summer for controlling odors at Lockport and Joliet would run between $1000 and $1200 per day (R. 2255, JA-I, 441).

The testimony of Dr. Buswell may be summed up in the following colloquy (R. 2262, JA-I, 444):

(The Master)

Q. "Summing up, Doctor, I understand you are confident without further examination (a) that the quantities of chlorine that you have referred to would substantially ameliorate conditions, although you could not be confident it would eliminate all odors without experiment—"

A. "That is right."

Q. (b) "that you are confident that the quantities of chlorine that you have referred to would give as much amelioration as 3500 additional c. f. s. from Lake Michigan; is that a correct summation?"

A. "That is my opinion" (R. 2262, JA-I, 444).

Joseph W. Ellms, Commissioner of the Division of Sewage Disposal in the Department of Public Utilities in Cleveland, Ohio, testified that the use of chlorine for control of odors complained of in the Illinois Waterway, and particularly in the Brandon Road Pool, would reduce and perhaps eliminate such odors (R. 2093, JA-I, 456). Mr. Ellms testified that a chlorine plant to apply 50 tons per day could be built for considerably less than $300,000 (R. 2315, JA-I, 467). Mr. Ellms estimated that the construction of a 50-ton chlorination plant would take about 6 to 7 months for completion and perhaps a month or a month and a half longer for an additional 75-ton plant (R. 2314, JA-I, 467), but that if the contractor was building those machines it would not make very much difference in time whether he were building the number for 50 tons a day or for 75 tons a day (R. 2314, JA-I, 467). He testified further that sufficient chlorine storage could be provided for a 15 or 20 day supply (R. 2315, JA-I, 467).

Mr. Ellms further testified that in his practice he has applied chlorine to water and also to sewage (R. 2302, JA-I, 461); that chlorine is applied to the influent at the two plants in Cleveland, Ohio, and also to the effluent as well. The quantities applied to the influent run from 3 to 5 p. p. m. and to the effluent, in the one case, 4 or 5 p. p. m. and in the activated sludge effluent 2 to 3 p. p. m. (R. 2303, JA-I, 461). Chlorine has been applied for the purpose of preventing any odors which may arise from the sewage entering the plant and in effluent from the plant it has been applied to keep down the pollution of the lake water in the vicinity of the bathing beaches of Cleveland that has been carried on through about 100 days during the summer months or during the bathing beach season (R. 2304, JA-I, 462).

Mr. Joseph Warrick, State Sanitary Engineer of Wisconsin, testified that the use of chlorine would tend to

ameliorate or remedy conditions complained of in the Illinois Waterway and particularly at the Brandon Road Pool without any increase in the diversion of water from Lake Michigan (R. 2105, JA-I, 476).

Mr. Warrick testified that the range in quantities of chlorine to be used would be from 3 to 5 p. p. m. for a treated effluent, completely treated effluent, from 5 to 10 p. p. m. for a primary treated effluent, that is, with the settleable solids removed, and from 10 to 20 p. p. m. for a screened or raw sewage, those being recognized as rough brackets of chlorination with some sewages (R. 2111-2112, JA-I, 477). Mr. Warrick testified that the application of chlorine at Brandon Road Pool or immediately above would be the most beneficial as regards conditions at Joliet and Lockport (R. 2248, JA-I, 483-484).

Mr. Warrick pointed out that the placing of chlorine in at several points would have a pasteurizing effect; that even though there was no available chlorine showing up by tests there would be a beneficial action and that experience has shown that chlorine applied ahead of septicity has reduced the amounts of chlorine, the overall amounts that are necessary and therefore several points of application would be beneficial (R. 2248, JA-I, 483-484).

Louis R. Howson, a witness called on behalf of the opposing Great Lakes States, is a consulting hydraulic and sanitary engineer.

He testified that chlorination is a very effective and positive method of controlling odors and that in his opinion it would be practicable and effective along the Illinois Waterway to relieve the conditions complained of, particularly at Joliet and Lockport (R. 1943-4, JA-I, 339). Mr. Howson testified that in his opinion one or a combination of the ameliorating or remedial measures suggested by him to ameliorate or remedy the conditions complained

of along the Illinois Waterway would afford the same relief that would be afforded by the addition of 3500 feet of water from Lake Michigan (R. 1951, JA-I, 340).

In a chart introduced by Mr. Howson, Opponent's Exhibit 11 (R. 2832, JA-II, 104) Mr. Howson estimated that 6 p. p. m. of chlorine would be required on the entire canal flow of 3130 c. f. c. and that this would cost $360,000 to provide the installation of the equipment required to utilize the chlorine for chlorination of the canal water and that the annual operating cost would be approximately $70,000 to $300,000 (Opponent's Exhibit 12, R. 2847, JA-II, 105); that the time required to provide this equipment would be from 6 to 9 months (Opponent's Exhibit 12, R. 2847; JA-II, 105). Mr. Howson's estimate of 6 p. p. m. of chlorine required to control the odors complained of with a total flow of 3130 c. f. s. measured at Lockport, would amount to about 50 tons of chlorine per day (Opponent's Exhibit 11, Item 5, R. 2832, JA-II, 104).

Among the witnesses who were called by the Petitioner State of Illinois to testify concerning the use of chlorine for odor control and for reduction of B. O. D. were Mr. Langdon Pearse, Dr. Floyd W. Mohlman of the Sanitary District of Chicago, and Mr. C. K. Calvert of Indianapolis, Indiana. The witnesses disagreed with the Lake States' theory that chlorination would be an effective feasible ameliorating measure because of the cost and alleged doubt as to the efficacy of this treatment as applied to such a heavily polluted stream as the Illinois Waterway (Report of Special Master Lemann, pp. 87-89).

3. *Chlorination of the West Side Imhoff tank effluents.*

In addition to the use of chlorine by applying the chlorine to the waters of the Main Channel of the Chicago Drainage Canal and to the Brandon Road Pool, another ameliorating measure which could be adopted is the application

of chlorine directly to the West Side Imhoff tank effluents (Howson, R. 2840-2842, JA-I, 344-345; Ellms, R. 2089-2093, JA-I, 454-456; Enslow, R. 2024, JA-I, 406-407; Opponents' Exhibit 12, Item 9, R. 2847, JA-II, 105). Mr. Howson testified concerning the application of chlorine directly to the West Side effluent that chlorination of the effluent of the West Side Imhoff tanks would do most of what could be accomplished by chemical precipitation and at a vastly lower expense (R. 2840-42, JA-I, 344-345). It would cost about $100,000 to install the equipment for chlorinating this effluent for 150 days a year, and would cost less to operate such equipment. He stated that such installation could be made in from six to nine months and that Mr. Enslow had advised him the figures of cost given for this item on Opponent's Exhibit 12 are sufficient to effect a reduction of 15 parts or more in the B.O.D. of the West Side Imhoff tanks. That would be equivalent to approximately 50,000 pounds of B.O.D. removed as compared to 76,000 pounds by the chemical precipitation method as shown on Opponents' Exhibit 11, JA-II, 104 (R. 2840-2841, JA-I, 344-345).

Mr. Ellms testified (R. 2090-2093, JA-I, 454-456) that the effluents of the sewage disposal plants at Cleveland, Ohio, have received treatment with chlorine for the past 17 years; that the City of Cleveland discharges the effluents of its disposal plants into the same body of water from which the City draws its water supply and that chlorine is used as a sanitary protection, to a certain extent, to the water supply, and that the orders of the Ohio State Board of Health were that Cleveland should also use chlorine in connection with keeping the marginal waters in as clean a condition as possible during the bathing season (R. 2091, JA-I, 455). Ellms testified that chlorine is used at two of the sewage treatment plants but that the plant whose effluent is discharged in the Cuyahoga River is not treated with chlorine, but during the summer

bathing season, between the last of May and the middle of September, chlorine is applied to the effluents of the two lake front plants (R. 2091-2092, JA-I, 455-456).

Mr. Ellms then gave his opinion that based on his experience in controlling odors which he assumed were as applicable to the effluent of the Sanitary District of Chicago as those of Cleveland, Ohio, chlorine has a beneficial effect upon odor nuisances, particularly those odor nuisances that might be derived from the development of hydrogen sulphide (R. 2092, JA-I, 455-56). Mr. Ellms' conclusion was that for reduction or elimination of hydrogen, sulphide, chlorine is an effective agent (R. 2093, JA-I, 456).

Mr. Enslow gave it as his opinion that considering the difference in cost involved between what is obtainable with chemical precipitation and what is obtainable with chlorination, that chlorination would be the quicker and simpler thing to use and that chlorine so used by application to the West Side effluent a much lesser amount of chlorine would be applied to the Canal waters direct (R. 2024, JA-I, 406-407).

Considering the fact that chlorination is now so universally used in modern sewage treatment as an effective agent for the reduction of B. O. D. and for odor control (Howson, R. 2841, JA-I, 344) and considering the experience had at Cleveland, Ohio, as related by Mr. Ellms (R. 2090-2093, JA-I, 454-456), it is clear that chlorination of the West Side Imhoff tank effluent would be an effective ameliorating agent in improving conditions in the Illinois Waterway, particularly at the Brandon Road Pool.

The cost of an installation to provide chlorination of the West Side effluent would be $100,000. Such an apparatus could be installed in from 6 to 9 months and the annual operating cost for 150 days of warm weather each

year would be $105,000 (Opponents' Exhibit 12, R. 2847, JA-II, 105; Howson, R. 2840, JA-I, 340).

4. *Properly constructed cascades at the site of the old controlling works near Lockport which would provide an average dissolved oxygen pickup of at least 6¾ parts per million with an average flow of 3130 c. s. f.*

The use of cascades by the construction of temporary structures at the site of the old controlling works about one mile northeast of the present power house and controlling works of the Sanitary District of Chicago would be very effective in providing, through reaeration, additional dissolved oxygen of about 6¾ parts per million with an average flow of 3130 c. s. f. (Opponents' Ex. 10, R. 2828, JA-II, 103; Warrick, R. 2107, JA-I, 476; 2233-2236, JA-I, 479; Pearse, R. 195, JA-I, 97; Mohlman, R. 239, JA-I, 195).

In his direct testimony Mr. Pearse, Sanitary Engineer for the Sanitary District of Chicago, in discussing the reasons why activated sludge was chosen to supplement the West Side Imhoff tanks, stated:

> "Second: In studying the problem of maintaining The Illinois Waterway in a suitable condition a number of unknown factors or contingencies have appeared which are beyond the control of the Sanitary District, such as the development of water power, which would practically stop all reaeration at dams. Such reaeration is of value in the self-purification of the waterway" (R. 195, JA-I, 97).

Dr. Mohlman in discussing dissolved oxygen in the waterway said, in part:

> "That brings in assets of dissolved oxygen. Then we can also get additional assets from the absorption of oxygen in the air. We can get it from aeration going over dams, or any such method of agitation. There is

a certain amount in the effluents from the sewage treatment works, although a rather low amount" (R. 239-240, JA-I, 195).

Warrick based his opinion upon results obtained at the Hastings Dam below Minneapolis, where considerable dissolved oxygen was gained in the water through reaeration over this dam (R. 2233-2236, JA-I, 479).

The experience of the Sanitary District itself is definite proof of the value of the use of cascades in providing additional dissolved oxygen through reaeration for purification of the Illinois Waterway. The Sanitary District of Chicago has provided cascades in the outfall sewers of the North Side Sewage Treatment Plant, and the following table, taken from State of Illinois Exhibit No. 20 (R. 142-147), shows during the period 1934-1939 inclusive an average of 6.7 parts per million of dissolved oxygen has been provided by the cascades in the outfall sewers at this plant:

		Average for Year P.P.M. Dissolved Oxygen		P.P.M. Gained Through
Record	Year	Final Settling Tanks	Outfall Sewers	Cascading
142	1934	1.4	8.0	6.6
143	1935	2.5	9.3	6.8
144	1936	2.2	9.0	6.8
145	1937	2.0	8.9	6.9
146	1938	2.7	9.4	6.7
147	1939	2.2	8.7	6.5
		Average gain for six years		6.7

It will be seen from the foregoing that the results obtained by the Sanitary District by cascading at this particular point confirms Mr. Howson's estimates that 6¾ parts per million of dissolved oxygen can be supplied by this means.

The record of tests made by Mohlman further establishes that the results of the ten-day tests undertaken from December 2nd to December 12th, 1940, show there was a gain through reaeration over the Brandon Road Dam of an average of about 9½ parts per million of dissolved oxygen.

Mr. Warrick pointed out that if the percentage saturation at the point of cascading is around zero it is possible to put in as much as 50 to 75% of saturation by the cascading procedure (R. 2240, JA-I, 481-482) and that under summer conditions the figure of about 8½ to 9 parts per million is taken as 100% saturation and the amount restored would be 50% to 65% of that amount.

Mr. Warrick pointed out that while it was difficult to state how long the dissolved oxygen would last, yet such oxygen is all the time using, that is, satisfying the B.O.D. as it is passing downstream (R. 2240, JA-I, 481-2). Mr. Warrick also pointed out that the addition of dissolved oxygen to the water through reaeration by cascading is an ameliorating step to the extent to which it would supply oxygen to the water (R. 2244, JA-I, 482-483).

Mr. Howson estimated that the time required for building temporary cascades at the old controlling works would be from three to six months and that the cost would run from $50,000 to $100,000 (Opponents' Exhibit 12, item 4; R. 2847, JA-II, 105).

The suggestions that the cascades would create a local odor and waste $1500 worth of power per day are wholly without merit. As Enslow pointed out (R. 2009, JA-I, 402-3) any local odor nuisance could be taken care of by chlorine. The objection that it would waste $1500 worth of power per day is untenable because if an emergency exists and there is a health hazard, which we do not admit, profits of quasi-municipal corporations derived from the

development of power should give way to the overwhelming demands of health protection. However, as we have shown before there is no emergency, nor is there any actual menace to the health of inhabitants due to the condition of the Illinois Waterway as a result of receiving untreated sewage.

The contention made by Illinois that the construction of cascades would provide a very inadequate means for improvement of conditions in Brandon Road Pool in 1941 and 1942 and would in no way compare with the advantage of diluting water is first an admission that the construction of cascades would provide some improvement while their argument in favor of additional diversion is not properly made because not within the scope of reference, which specifically refers to ameliorating measures without additional diversion of water from Lake Michigan.

The fact that the Sanitary District of Chicago uses cascades successfully in its outfall sewers at the North Side and Southwest Plants demonstrates that properly constructed cascades would be a feasible ameliorating measure.

5. *The installation of chemical treatment as a temporary measure for the further purification of the Imhoff tank effluent at the West Side treatment works.*

Another emergency measure which is practicable and which could be undertaken for the years 1941 and 1942 or until the completion of the additions required under permanent program of the Sanitary District of Chicago is the addition of chemicals to Imhoff tank effluent at the West Side plant.

Howson suggested the installation of chemical treatment for further purification of the Imhoff tank effluent at the West Side plant as an emergency measure for a two year period (R. 2830). Opponents' Exhibit 11, JA-II, 104,

shows that chemical treatment at the West Side plant would reduce the B.O.D. of the West Side sewage by 21 parts per million. Howson's opinion is supported by A. M. Buswell who made a study of the use of chemical treatment at the West Side works for the P.W.A. Engineering Board of Review in 1932 (R. 1888-1889, JA-I, 431-432). Dr. Buswell then reported that with proper dosage of chemicals to the West Side effluent a 75% purification could be obtained (R. 1890, JA-I, 432) and Dr. Buswell testified that it was still his opinion that if the existing Imhoff tanks were supplemented with proper chemical treatment of the Imhoff tank effluent a 75% purification could be obtained instead of the present average purification of about 50%.

The cost of chemical treatment at the West Side plant is shown on Opponents' Exhibit No. 12 (R. 2847, JA-II, 105) and the initial investment would be approximately $1,300,500. The necessary equipment could probably be installed by the summer of 1941.

Buswell estimated the operating cost of a chemical plant for further purification of the Imhoff tank effluent at the west Side plant at from $6,000 to $8,000 per day (R. 2291, JA-I, 452).

There is no dispute whatsoever concerning the feasibility of the final permanent program adopted by the Sanitary District and the only question here is whether chemical treatment at the West Side works for further purification of the West Side Imhoff tank effluent is an ameliorating measure which is available to the State of Illinois without the diversion of additional water from Lake Michigan. We believe the record amply establishes that if any further assurance is required by the inhabitants of Lockport or Joliet concerning the condition of the Illinois Waterway, particularly the Brandon Road Pool,

during the summers of 1941 and 1942, the State of Illinois and its agency, the Sanitary District of Chicago, can and should give proper consideration to the use of chemical treatment at the West Side works as an ameliorating measure.

6. *Increased use of air at the North Side and Calumet activated sludge plants. This would be an effective ameliorating measure in improving the conditions complained of on the Illinois Waterway.*

Additional oxygen to balance the B.O.D. in the Illinois Waterway could be obtained by the increased use of air at the North Side and Calumet Plants (Howson, R. 2825; Warrick, R. 2105, JA-I, 476; Ellms, R. 2090, JA-I, 454; Buswell, R. 1892-1895, JA-I, 433-434; Opponents' Exhibit 10, R. 2828, JA-II, 103; Opponents' Exhibit 12, Item 1, R. 2847, JA-II, 105). The equipment is already installed; hence there would be no initial capital expenditure for installations and the only cost would be some additional cost in the purchase of electricity for operating the equipment already there (Opponents' Exhibit 12, R. 2847, JA-II, 105). The annual operating cost based on 5 months operation, would be $89,000 while the annual cost based on 12 months operation, would be $216,000. There would be no time required for installations which are already available. By the use of increased air the equivalent of 55,000 pounds of oxygen could be added per day in the form of nitrate and nitrite oxygen (Towson, R. 2825).

Dr. Buswell, a witness testifying on behalf of the respondent Great Lakes States, stated that an increase in air beyond that required to merely produce bio-precipitation results in the formation of nitrates and nitrites from the nitrogenous material in the sewage and that it has been known for many years that nitrates carry oxygen available for the stabilization of the B.O.D. load in a polluted

stream, and that in fact, up to 1920 an analytical method based on that property was used to estimate the B.O.D. load. Buswell stated that he did not know of any streams with nitrates and nitrites present in the water where septic conditions occurred. He stated further that nitrates, in his experience, tend to oxidize hydrogen sulphide if it is produced in some portion of the stream, and also to prevent the formation of hydrogen sulphide. The bacteria, in decomposing organic matter, require oxygen in order to burn the organic matter and supply energy for their own growth and they take the oxygen first from the dissolved oxygen and then from nitrates and then from sulphates; and the end product left when they take the oxygen away from sulphates is hydrogen sulphide (R. 1892-1894; JA-I, 433-434).

Mr. Warrick, State Sanitary Engineer of Wisconsin, testified that the use of an increased amount of air at the several activated sludge plants in the Chicago Sanitary District would have a beneficial effect on the Illinois Waterway, particularly from the point of view of putting additional oxygen into the effluent from the point of view of production of nitrates with the available oxygen from nitrates and tending to ameliorate conditions in the water in which they are discharged (R. 2106, JA-I, 476).

Ellms testified that one of the ameliorating measures available to the State of Illinois without an increase in diversion of water from Lake Michigan to ameliorate the conditions complained of along the Illinois Waterway, would be by the use of a large quantity of air at the activated sludge plants which might produce a large quantity of residual dissolved oxygen and also, possibly by the presence of certain amounts of nitrates which become available if the dissolved oxygen were doubled (R. 2090, JA-I, 454).

Ellms, when asked what is available as oxygen for biochemical activity by the presence of nitrates and nitrites, stated that—

> "The ordinary sodium nitrate would provide about one pound of oxygen for every 1.77 pounds of nitrate, * * * or to put it another way—one pound of nitrogen as nitrate will produce about 3.4 p. p. m. of oxygen." (R. 2090, JA-I, 454).

While it might be more economical to use as little air as possible consistent with a high degree of B.O.D. removal under ordinary cricumstances, it is manifest that in the case of an emergency or where temporary ameliorating measures are necessary to grant assurances to inhabitants on the Watercourse into which the effluent from sewage treatment plants is placed, then economies should be dispensed with and additional monies expended in increasing the air so as to obtain additional oxygen and nitrates and nitrites to balance the B.O.D. in polluted watercourses. The use of increased air at the North Side and Calumet plants is clearly an ameliorating measure which could be undertaken at once with existing installations without any initial capital cost and with an operating cost for five months of only $89,000 (Opponents' Exhibit 12, R. 2847, JA-II, 105). The benefits from the adoption of this measure would be very appreciable and coupled with the increased degree of purification of the sewage of the Sanitary District of Chicago, would assist in maintaining satisfactory conditions on the Illinois Waterway and particularly at Brandon Road Pool.

7. *The planned use of water permitted under the decree of April 21, 1930, will allow the Sanitary District of Chicago to divert approximately 2200 c.s.f. plus domestic pumpage or a total flow of 3850 c.s.f. during the four warm months of each year.*

The State of Illinois' Exhibits 12, R. 56-57, 13 R. 62, and 40 A (JA-II, 39) show the amount of diversion of water from Lake Michigan during the years 1939 and 1940. It will be noted from an examination of these exhibits that during critical warm months the dry weather diversion from May to October in the year 1939 (Illinois' Exhibits 12 and 40) amounted to an annual average of 1090 c.f.s. (R. 56-57, JA-II, 39). It is obvious that if the direct diversion permitted under the Supreme Court decree of April 21, 1930, limiting the annual average diversion to 1500 c.s.f. plus domestic pumpage were budgeted so as to provide an increased flow during the four warm months of the summer, that conditions in the Illinois Waterway during the hot weather would be improved by the additional oxygen in the water at the time when it is most needed.

Under the planning, suggested by Howson (Opponents' Exhibit 10, item 5, R. 2828, JA-II, 103) there would be provided during the four warm months of each year a total of 4200 c.f.s. measured at Lockport. This planned use of the water would double the dry weather diversion in the times when more oxygen is needed and could be so arranged that it could be taken either during the months of June, July, August and September or from the middle of May to the middle of September of each year.

It is admitted by Ramey that the Sanitary District could operate very nicely with a total flow of 2400 c.s.f. each month, and adding to this the average storm flow of 400 c.s.f. would permit a total withdrawal of water measured at Lockport of 2800 c.s.f. for eight months of the year

or during the Fall, Winter and Spring months. During the remaining four months of hot weather the amounts that have been saved during the eight months of cool weather would be utilized to provide additional oxygen so as to improve the conditions of the Illinois Waterway during the summer months of each year. This regulation of the annual flow so as to equalize the pounds of oxygen which might be obtained in additional water diverted would provide about 22,000 pounds of extra oxygen per 24 hours and would be beneficial in ameliorating conditions along the Illinois Waterway (Opponents' Exhibit 10, R. 2828, JA-II, 103).

The Sanitary District has, it is true, since the opening of hearings before the Special Master, adopted a limited plan of budgeting the diversion within the decree so as to provide a flow of 3,700 c.f.s. during the summer months, as compared with the 4200 c.f.s. thought feasible by Mr. Howson. We believe the Sanitary District could enlarge its planned use of water under the decree to provide a diversion of 4200 c.f.s. during the summer months (Report of Special Master Lemann, pp. 99-102).

8. *Cleansing of the Brandon Road Pool by Hydraulic Dredging.*

It is agreed by the Sanitary Engineers that a part of the trouble caused in the Brandon Road Pool is traceable to the deposits of light flocculent active sludge and heavier deposited materials in the Brandon Road Pool. The sludge exerts an oxygen demand and contributes to the unsatisfactory conditions in that reach of the Illinois Waterway concerning which complaints have been made.

The Special Master called as a witness C. R. Andrew, Principal Civilian Assistant to the U. S. District Engineer at Chicago, Illinois, who testified to the location and physi-

cal characteristics of the Brandon Road Pool and to the character and extent of the deposit of solids therein (R. 2033-2034, JA-I, 255; Andrew's Exhibits 4 and 5). Mr. Andrew was asked by the Special Master whether the sludge that is present in the Brandon Pool and at other points in the Sanitary Canal could be removed by hydraulic means (R. 1501, JA-I, 250) Mr. Andrew defined sludge as having reference to that "material which has settled out of the water and is so much heavier than the water that it has formed deposits so solid that the surface may be detected by ordinary sounding methods, that is, by sounding line or lead line. In the case in question, the survey was made with a lead line, with a 10 lb. lead weight, and attached to the bottom of that was a 10" disk, so that that defines the surface of any material which I may call sludge" (R. 1501, JA-I, 250). Mr. Andrew testified that the depth of the sludge deposited in the Brandon Road Pool was from 2 to 10 feet deep (R. 1503, JA-I, 250), that the deposits were mainly below Jefferson Street in Joliet with no appreciable deposits above Jefferson Street (R. 1503, JA-I, 250). Mr. Andrew testified that the material he spoke of could be removed by hydraulic methods (R. 1503, JA-I, 250). Mr. Andrew's best judgment was that it would cost between $500,000 and $750,000 to remove the deposits of sludge which were 'between a million and a quarter and a million and a half yards (R. 1504, JA-I, 251). He stated that it would take from 6 to 9 months to do this and that it would not necessarily interfere with navigation and that the sludge removed could be deposited in vacant areas in what is known as Hickory Creek Valley (R. 1504, JA-I, 251), and that it would take between 200,000 and 250,000 square yards which would be about 400 acres (R. 1505, JA-I, 255). The land available, Mr. Andrew stated that this deposited material had accumulated during all of the years, even during the period when the amount of water taken from Lake Michigan was considerably greater

than it is today—that is, even when the flow was 8500 c.f.s. and when it was 5000 c.f.s. (R. 1505-1506, JA-I, 251).

Mr. Andrew testified further that an increase in diversions to 500 c.f.s. would not remove the accumulated deposits (R. 1506, JA-I, 251).

Mr. Howson presented his views on dredging of the Brandon Road Pool to remove the more compact solids and some of the lighter flocculent active solids in Opponents' Exhibit 12 (R. 2847, JA-II, 105). He stated that the approximate cost would be between $400,000 and $750,000 with no annual operating cost.

The removal of the more solid deposits and some of the lighter flocculent active material by hydraulic dredging and the deposit of such material in the lagoon downstream near Hickory Creek (R. 1504, JA-I, 251), would cause no trouble and be the source of no complaints.

While there may be some doubt as to the actual benefits to be derived from the removal of all of the deposited heavier sludge in the Brandon Road Pool, yet it is certain that if there is any question as to the effect of such heavy deposited material or the lighter sludge above such heavier solids, then in order to provide additional assurances of satisfactory conditions in Brandon Road Pool the removal of such heavy solids should be undertaken by hydraulic dredging and such removed material be deposited in Hickory Creek Valley section or farther downstream along the banks of the Dresden Island pool where no people reside who could complain of the odors caused by the presence of this deposited material.

9. *The additional treatment of the West Side effluent in the Southwest aeration tanks would provide increased purification of all of the sewage of the West-Southwest area.*

Another ameliorating measure available to the State of Illinois without an increase in diversion of water from Lake Michigan and which would not interfere in any way with their permanent program would be to provide additional final settling tanks for the Southwest Activated Sludge Plan (Opponents' Exhibit 12, R. 2847, JA-II, 105). The expenditure of funds in this way would, as an emergency measure, provide conditions which would be permanently useful and would not interfere with the permanent construction program of the Sanitary District (Howson, R. 2838-2839, JA-I, 343-344).

Mr. Howson, a witness for the opposing Great Lakes States in explaining Opponents' Exhibit 12, Item 8, testified that: The diversion of all West Side effluent to the Southwest aeration plant, all of which is a part of the permanent program of the Chicago Sanitary District, would require the expenditure of about three million dollars; that this could be done so as to be all or very largely in use by the summer of 1941 if it were organized and pushed immediately; that such diversion of the West Side effluent and treatment at the Southwest plant would reduce the present B.O.D. demand about 200,000 pounds per day, or some 40% (R. 2838-2839, JA-I, 343-344).

Mr. Pearse, a witness called on behalf of the State of Illinois, criticised this suggestion ameliorating measure on the ground that it would interfere with the permanent program of the Sanitary District and also on the ground that Mr. Howson had not included several items which in the judgment of Mr. Pearse would increase the cost considerably.

It will be seen, however, that the suggestion of Mr. Howson, for a slight change in the permanent construction program as to items of construction and with the expenditure of but a small additional amount of money, the Sanitary District could have available in 9 months, and in any event, have ready by the spring of 1942 the necessary additions required to provide aeration for the West Side effluent which would decrease or reduce the B. O. D. load to the Canal by about 200,000 pounds per day or some 40%. If this were organized and pushed at once this could be done so as to very largelybe in use by the summer of 1941 (Howson, R. 2839, JA-I, 343-344).

10. *Universal metering of the water supply of the City of Chicago.*

Universal metering of the entire water supply of the City of Chicago, if undertaken at once and vigorously pressed would permit the installation of 30-50,000 meters in one year (Howson, R. 3253, JA-I, 362-363). This would reduce the domestic sewage flow principally in the Southwest area if the metering program were concentrated therein (Howson, R. 3253). Metering of the water supply of Chicago has been advocated for a great many years and a report was made in 1915 recommending meters (Howson, R. 3254, JA-I, 363). Moreover, metering of the Chicago water supply has been urged by various agencies. The permit of the Secretary of War dated March 3, 1925, to the Sanitary District of Chicago required metering as a part of the permit (Opponents' Exhibit 9, R. 2820). The report of the Board of Review (P. W. A.) dated April 30, 1934, likewise required metering in the South Side of Chicago as a part of the agreement between the P. W. A. and the City of Chicago in the construction of the South Side water filter plant (Howson, R. 2821).

If the Chicago water supply were metered this would unquestionably reduce the per capita consumption of water

in Chicago (R. 2818). That has been the universal experience of all states where a metering program has been adopted (Opponents' Exhibit 8, R. 2816).

A cut in the water consumption would mean that a longer period of detention of the sewage could be provided in the aeration tanks which would increase the efficiency and degree of purification so that the effluent from the activated sludge plants would reach the Illinois Waterway with 1 or 2 p. p. m. more of dissolved oxygen in the effluent and with nitrates and nitrites to balance the oxygen demand in the Waterway. Moreover, a cut in the flow of sewage by metering would make available more capacity in the sewage treatment plants for storm water in the intercepting sewers (Pearse, R. 1795). A cut in the sewage flow would also extend the useful life of the sewage disposal plants (Pearse, R. 1783, JA-I, 155).

While it may be difficult to give any relief through metering in 1941, it is certain that metering ought to be undertaken at once to stop the enormous wastage of water now taking place and to preserve the useful life of the Sanitary District's plants (Report of Special Master Lemann, pp. 102-104).

11. *The State of Illinois Should Be Required to Proceed with Each and Every Remedial or Ameliorating Measure Suggested at the Hearings, either Singly or in Combinations, before any Additional Diversion of Water from Lake Michigan Is Recommended as an Ameliorating Measure.*

The record establishes that no additional diversion of water from Lake Michigan is necessary to protect the health of the inhabitants of the complaining communities. However, in the event that the State of Illinois wishes to furnish any additional assurances to the inhabitants of the complaining communities or to improve the present con-

dition of the Illinois Waterway at Lockport and Joliet, the State of Illinois should be required to proceed first with each and every ameliorating or remedial measure suggested at the hearings and discussed by the Master in his Report, either singly or in combinations, before any additional diversion of water is recommended as an ameliorating measure.

The respondent Great Lakes States have consistently urged in connection with other suggestions of the use of chlorination as well as their other suggestions for ameliorating measures, that admitting but not conceding that there might be room for doubt as to the efficacy of such measures, and admitting that some expense would be involved in the use of each of them, Illinois should be required to try each and all of them before being permitted to divert any more water from the Great Lakes-St. Lawrence Watershed. As the Special Master points out there is much force in this contention from the standpoint of the general principles of law and equity which control in ordinary litigation (Report of Special Master Lemann, p. 90). We submit that it is clear on the record that in view of Illinois' lack of equity herein and in view of the admissions of the experts for the State of Illinois, that some good might be accomplished from the use of the remedial measures suggested. It would seem reasonable to require Illinois to try each and all of the available ameliorating measures before being permitted to take one drop of additional water from Lake Michigan.

At this point, we wish again to point out that the unsatisfactory conditions in the Illinois Waterway, particularly at the Brandon Road Pool, of which complaints were made, were and are caused in part by the fact that the municipalities and private industries located along or adjacent to the Sanitary Drainage Canal and the Des Plaines and Illinois Rivers dump their raw sewage into the Illinois

Waterway; and that among such municipalities and private industries are the Texas Company, Argo, Lemont, Lockport and Joliet and the State of Illinois which operates the two State Prisons at Joliet, the raw sewage of which is dumped into the Chicago Drainage Canal (Pearse, R. 1656, 1781, 2555-2558, JA-I, 124-125, 163; Cheadle, R. 435-436, JA-I, 585-586; Testim, R. 1391, JA-I, 697; Jones, R. 294, 296, JA-I, 570.

Illinois in its exceptions suggests that these communities are now undertaking to complete sewage disposal plants. We are unable to find anything in the record which bears out this contention except that the record does show that Joliet had discussed sewage disposal plans with a sanitary engineer but that there was nothing definite in its plans to complete in the near future any sewage disposal plant. Likewise the other communities are all apparently waiting until the Sanitary District of Chicago completes its entire project before engaging in such an undertaking (Cheadle, 435-436).

2. ARGUMENT ON OPPOSING THE LAKE STATES EXCEPTION WITH RESPECT TO THE FAILURE OF THE SPECIAL MASTER TO MAKE A FINDING THAT THE ACTUAL CONDITION OF THE ILLINOIS WATERWAY AT JOLIET AND LOCKPORT, ILLINOIS, WILL RESULT IN NO NUISANCE CONDITIONS WITH RESPECT TO ODORS DURING THE SUMMER MONTHS OF 1941.

The record conclusively establishes that the actual condition of the Illinois Waterway today is such as to result in no nuisance conditions affecting health and that no increase in diversion though temporary in nature is necessary to protect the health of the inhabitants of the complaining communities to-wit: Lockport and Joliet, Illinois. We believe further, that the actual condition of the Illinois Waterway at Joliet and Lockport during the summer months of 1941 and thereafter will result in no nuisance

conditions with respect to odors. We have discussed in this brief hereinbefore at pages 33 to 36 in general the conditions which will exist at Lockport and Joliet in 1941 and thereafter. We respectfully refer the Court to this discussion on this exception of the opposing states.

3. ARGUMENT ON EXCEPTION RELATING TO THE MANIPULATION OF THE DIVERSION OF WATER FROM LAKE MICHIGAN FOR POWER PURPOSES.

3. *While the petition of Illinois is based on a claim of a menace to public health the record conclusively establishes that one of the motives behind the request for increased diversion is to obtain additional water at Chicago from Lake Michigan for power purposes.*

The State of Illinois in its petition for increased diversion through the year 1942 predicates its case entirely on the alleged menace to public health. We submit, however, that the record conclusively establishes that the claims of injury to health to persons residing or working on or along the Illinois Waterway at Joliet and Lockport are grossly exaggerated and not sustained by the record. The record does establish that one of the motives behind this demand for additional water from Lake Michigan is power. The record further establishes that with the direct flow of 1500 c. f. s. plus domestic pumpage, the Sanitary District of Chicago, the agency of the State of Illinois, has earned a profit of at least $1500 per day (Report of Special Master Lemann, p. 91) During the ten day flushing test from December 2nd through December 12, 1940, the Sanitary District made a profit of $12,500 in addition to their regular $1500 per day profit from the direct diversion authorized by the Supreme Court (Report of Special Master Lemann, p. 82).

The Master found that the odors at Joliet along the Illinois Waterway were worse at night or in the early

morning than they were during the day (Report of Special Master Lemann, p. 15). As in the past, the Sanitary District of Chicago is manipulating the flow through the Chicago Drainage Canal for power purposes to provide greater flows during the nighttime when the power load goes on (Christman, R. 630, 632-633; JA-I, 609; Cheadle, R. 426-427; Ramey, R. 1586; JA-1, 50; Illinois Exhibit 43, R. 1431-1432; JA-II, 41; Deneau, R. 799; JA-I, 626). It is manifest from the foregoing that the increased flow was a contributing factor to the creation of odors in the Waterway when such odors occurred.

As the Special Master suggests, the entire attitude of the Sanitary District of Chicago has been influenced not by any desire for speed or for an early completion of the large building operations necessary to complete the sewage disposal program as required by the decree of this court of April 21, 1930, but by the purpose to complete its program at as little expense as possible to its taxpayers (Report of Special Master Lemann, p. 107). And as the Special Master further points out, "another conflict in interest arises from the fact that the taxpayers of the Sanitary District do not appear to have suffered from any nuisance conditions due to delay in completing sewage treatments; the complaints come only from those residing near the Canal in Joliet and Lockport, who are not taxpayers of the District (Report of Special Master Lemann, p. 107). Moreover, as Mr. Pearce, Sanitary Engineer for the Sanitary District of Chicago, testified, that since the water in the Illinois Waterway was not used for drinking purposes he did not concern himself with B. Coli figures and that their work primarily was not concerned with destroying bacteria (Report of Special Master Lemann, p. 36).

It will thus be seen that the State of Illinois, and particularly the Sanitary District of Chicago have at no time

been particularly concerned about any health problem at Joliet or Lockport. The chief concern has been to economize and to obtain as large a profit from the development of water power at Lockport as possible. The amount of profit from water power is, of course, directly proportionate to the amount of diversion of water from Lake Michigan.

APPENDIX II.

XVII. INDEX TO ARGUMENT ON EXCEPTIONS OF THE STATE OF ILLINOIS.

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